

THREADED CENTER LINE CAGE WITH FUNNEL SHAPED PROFILE

Background of the Invention

1 The present application is directed to a center line
2 threaded cage with a winged end cap for implantation between
3 a pair of adjacent vertebrae in order to provide spacing,
4 orientation, and support to the vertebrae and to promote
5 fusion between the vertebrae.

6 In the human spine, the pad or disc between vertebrae
7 is sometimes damaged or deteriorates due to age, disease,
8 injury, or congenital defect. The vertebrae may also become
9 compressed or otherwise damaged. Because of this, surgery
10 is often utilized to place spacers or interbody devices
11 between the vertebrae which provide proper spacing of the
12 vertebrae and which also promote fusion between the
13 vertebrae. When a device of this type is utilized for
14 purposes of promoting fusion, it is often referred to as a
15 fusion cage or an intervertebral fusion device. When
16 utilized to promote fusion, the interbody devices often are
17 windowed and packed with bone fusion material to promote
18 growth of the bone between the vertebrae. Sometimes such

1 material is packed between a pair of devices that are placed
2 in close proximity to one another between the vertebrae to
3 promote growth of bone and, therefore, fusion between the
4 vertebrae.

5 In the past, interbody devices have typically been
6 either generally rectangular or cylindrical in shape. The
7 cylindrical devices have an advantage that they can be
8 threadably received more or less directly between and into
9 the adjacent vertebrae. For this purpose, the vertebrae are
10 typically first spaced apart, and then a tool is utilized to
11 create a partial bore in each vertebra which with spacing of
12 the vertebrae allows the interbody device to be received
13 between the vertebrae. Because of the natural space between
14 the bones, the interbody device usually engages the bones
15 only along an upper surface and a lower surface thereof.
16 When the cage is of a cylindrical threaded type, the upper
17 and lower surfaces are curved and essentially designed to
18 engage the portion of the vertebrae where bone is unremoved
19 during boring to create an opening for the device.

20 When interbody devices of this type are used, it is
21 desirable that the device engage as much surface of bone as
22 possible to provide strength and to reduce the likelihood of
23 subsidence of the device into the bone, resulting from

1 contact pressure of the interbody spacer on an
2 intervertebral surface of a vertebra, since part of the bone
3 is spongy by nature, especially near the center. The
4 remainder of the structure mainly functions to support the
5 two engagement surfaces, unless the device is also used as a
6 cage within which to pack bone fusion material. Because it
7 is also desirable in such structures to maintain weight and
8 volume as low as possible, in order to make the device more
9 compatible with the body, it is also desirable to make the
10 entire device as small and lightweight as possible, while
11 maintaining sufficient strength to prevent catastrophic
12 failure.

13 As noted above, the mutually facing intervertebral
14 surfaces of an adjacent pair of vertebrae have different
15 characteristics over their areas. Central regions of the
16 surfaces are somewhat spongy, such that there is a tendency
17 of the interbody spacers to subside or sink into the
18 vertebrae in the central regions. In contrast, outer or
19 edge regions of the surfaces are more solid and generally
20 harder. When a fusion cage is implanted, particularly a
21 threaded cylindrical cage, it has previously been the
22 practice to implant two such cages in side-by-side relation
23 except where a wide flat device is used to essentially

1 replace the disc. This done for lateral stability of the
2 vertebrae, so that the vertebrae do not pivot laterally
3 relative to the interbody implant. Two such cylindrical
4 cages have also been used to increase the area of bearing
5 surfaces engaging the vertebral surfaces to thereby minimize
6 subsidence of the cages into the vertebrae. Implanting such
7 a pair of cylindrical cages requires that two bores be cut
8 into the vertebral surfaces to receive the two cages.

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10 Summary of the Invention

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12 The present invention provides an arrangement for
13 effective use of a single interbody spacer member by center
14 line positioning of a threaded interbody spacer or fusion
15 cage having a winged end cap for placement between a pair of
16 spaced apart, but adjacent vertebrae. In general, the
17 spacer member engages inner regions of the adjacent
18 vertebrae while the end cap engages the outer regions of the
19 vertebrae.

20 The interbody spacer is a threaded spacer, including
21 superior and inferior surfaces which have helical threads
22 cut into the surfaces in such a manner that the outer
23 surfaces of the threads form a partial cylindrical surface.

1 Lateral or side surfaces of the spacer member are
2 cylindrically concave to increase the intervertebral volume
3 available to receive spinal fusion promoting material to
4 fuse the adjacent vertebrae. A partial cylindrical spacer
5 receiving bore is cut into the mutually facing surfaces of
6 the spaced apart vertebrae along a median plane of the
7 subject spine, through the adjacent vertebra edge regions.
8 The spacer member is threaded into the bore, using an
9 implant tool, to a position in which the cylindrical
10 surfaces engage central regions of the upper and lower
11 vertebrae.

12 The end cap has superior and inferior surfaces
13 preferably shaped to conform to the natural shape of the
14 edge regions of the adjacent vertebrae, as modified by the
15 spacer receiving cylindrical bore formed into the surfaces
16 of the vertebrae. The end cap has connection structure for
17 securing the end cap to the spacer member. Preferably, such
18 connection structure includes an opposed pair of posteriorly
19 extending, resilient pawls which are adapted to snap into
20 recesses formed into the side surfaces of the spacer member.
21 The end cap preferably includes laterally extending wings or
22 extensions which are shaped to engage segments of the edge
23 regions of the vertebrae at positions spaced laterally of

1 the median plane. The wings wedge between the vertebrae to
2 prevent the vertebrae from tendencies to pivot laterally
3 about the spacer member positioned along the median plane.
4 The wings in conjunction with the midline spacer cooperate
5 to prevent side to side or lateral rotation about the
6 implant and thereby stabilize the vertebrae on either side
7 of the spacer relative to each other.
8 A central cavity may be formed through the interbody
9 spacer from one lateral surface to the other. The central
10 cavity is intended to receive additional bone fusion
11 material to promote fusion between the adjacent vertebrae or
12 opposite sides of the spacer. Alternatively, other openings
13 and apertures can be formed in the spacer. The end surfaces
14 may be provided with threaded bores to receive an
15 installation tool employed to implant the interbody spacer
16 between an adjacent pair of vertebrae. The end cap may also
17 be provided with openings, where they are structurally
18 appropriate, to receive the bone fusion promoting material.
19 The threads, which extend along and form major parts of
20 the superior and inferior surfaces of the spacer member,
21 have inner roots and outer crests. Outer surfaces of the
22 crests are substantially cylindrical segments, bounded by
23 intersections with the side surfaces of the spacer member.

1 That is, outer radii of the crests are preferably
2 substantially constant along the axial length thereof.
3 However, the radii of the roots of the threads generally
4 diminish in progressing in a posterior direction to near
5 approximately a midpoint and thereafter remain substantially
6 constant to the posterior of the spacer member. In
7 particular, the roots preferably diminish conically from
8 front to back to a middle region or somewhat posterior of
9 the exact middle. From that point to the posterior end, the
10 radii of the roots are constant or cylindrical, resulting in
11 an overall funnel profile shape of the thread roots and the
12 surface of the spacer member formed by the thread roots.
13 The purpose of the reduction in root radius near the front
14 or anterior of the spacer member is to provide greater
15 anterior support and thereby create or maintain a desired
16 lordotic angle or degree of lordosis of the vertebrae.

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18 Objects and Advantages of the Invention

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20 Therefore, the objects of the present invention
21 include: providing an improved arrangement for placing an
22 implant including interbody spacer structure between an
23 adjacent pair of vertebrae to maintain a desired spacing

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1 therebetween; providing such an interbody spacer structure
2 formed by a single, center line mounted spacer member, that
3 is, positioned in substantial alignment with a medial plane
4 of the body through the spine, and an end cap member
5 connected to and cooperating with the spacer member;
6 providing such a centerline spacer structure in which the
7 spacer member has substantially cylindrical surfaces and is
8 threaded for threading into a bore formed into and between
9 mutually facing surfaces of an adjacent pair of vertebrae;
10 providing such an arrangement in which crests of the spacer
11 threads are substantially equal in radius along the axial
12 length of the spacer while roots of the threads diminish in
13 radius from near an anterior end to near an axial midpoint
14 to provide greater support against subsidence on the
15 anterior side of the spacer to help support adjacent
16 vertebrae in a desired angular or lordotic relationship;
17 providing such a structure in which the radius of the root
18 of the threads diminishes at a constant rate from near an
19 anterior end toward the posterior end until near the axial
20 midline after which the radius of the thread root becomes
21 generally constant to provide a substantially funnel shaped
22 profile or funnel shape to the interior body or shape of the
23 spacer formed by the thread root; providing such a structure

1 in which the spacer member includes cylindrically concave
2 lateral or side surfaces that join the upper and lower
3 abutment surfaces on opposite lateral sides of the spacer
4 member; providing such an arrangement wherein the shape and
5 design of the interbody spacer member provides strength
6 while reducing volume and weight; providing such a structure
7 in which the spacer member can be either solid or partly
8 hollow and which is provided with openings in structurally
9 appropriate places in order to allow packing with bone chips
10 or other bone fusion promoting materials; providing such a
11 structure having a spacer with a thread that has a crest of
12 generally constant radius and a root that has a radius that
13 reduces evenly from near an anterior end to near an axial
14 center of the spacer and thereafter remain generally
15 constant so that the root forms a partial funnel shaped
16 surface; providing such a structure which minimizes surgical
17 alteration of the vertebral bones between which a threaded
18 cylindrical spacer is implanted; providing such a structure
19 which requires only a single interbody spacer member
20 positioned at a medial plane or centerline between the
21 adjacent vertebrae; providing such an arrangement including
22 a laterally extending stabilizing structure engaged with the
23 spacer member and the adjacent vertebrae to prevent pivoting

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1 of the vertebrae laterally about the single interbody
2 spacer; providing such an arrangement including an end cap
3 which is secured to the spacer member and which engages edge
4 regions of the mutually facing surfaces of the adjacent
5 vertebrae; providing such an end cap including wings or
6 extensions which extend laterally of the spacer member to
7 engage a substantial portion of the edge regions of the
8 adjacent vertebrae; providing such an end cap which is
9 secured to the spacer member by connectors, especially a
10 pair of opposed resilient pawls which extend posteriorly
11 from the end cap to engage recesses formed on the spacer
12 member; providing such an end cap including openings formed
13 therethrough to receive spinal fusion promoting material;
14 and providing such a threaded centerline interbody spacer
15 structure with a winged end cap which is economical to
16 manufacture, which is relatively simple to implant, which is
17 efficient in operation, and which is particularly well
18 suited for its intended usage.

19 Other objects and advantages of this invention will
20 become apparent from the following description taken in
21 conjunction with the accompanying drawings wherein are set
22 forth, by way of illustration and example, certain
23 embodiments of this invention.

1 The drawings constitute a part of this specification
2 and include exemplary embodiments of the present invention
3 and illustrate various objects and features thereof.

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5 Brief Description of the Drawings

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7 Fig. 1 is an enlarged exploded perspective view of a
8 centerline interbody spacer member and a winged cap
9 cooperating therewith which embody the present invention.

10 Fig. 2 is an enlarged longitudinal cross sectional view
11 of the interbody spacer member and illustrates a diminishing
12 radius of the thread root of the member from a front end to
13 a middle thereof.

14 Fig. 3 is a transverse cross sectional view of the
15 interbody spacer member, taken along line 3-3 of Fig. 2, and
16 illustrating a root shape and size of the member near a rear
17 end of the member.

18 Fig. 4 is a transverse cross sectional view of the
19 interbody spacer member, taken along line 4-4 of Fig. 2, and
20 illustrating a root shape and size of the member near a
21 front end of the member.

22 Fig. 5 is a fragmentary diagrammatic front elevational
23 view of a human spine, with a pair of adjacent vertebrae

1 separated by a spinal disc prior to installation of the
2 present invention between the vertebrae.

3 Fig. 6 is a view similar to Fig. 5 and illustrates the
4 spine subsequent to a procedure to remove the disc, with
5 intervertebral separating tools positioned between the
6 vertebrae.

7 Fig. 7 is a view similar to Fig. 5 and illustrates the
8 vertebrae separated by the separating tools and
9 cylindrically bored to produce radiused upper and lower
10 channels in the respective vertebrae to receive the
11 interbody spacer of the present invention.

12 Fig. 8 is a diagrammatic plan view, taken on line 8-8
13 of Fig. 7, at a reduced scale and illustrates a vertebra
14 after boring and with the separating tools in place.

15 Fig. 9 is a somewhat enlarged, fragmentary exploded
16 perspective view illustrating an interbody spacer member and
17 a spacer implanting tool assembly for use in implanting the
18 spacer member between an adjacent pair of vertebrae.

19 Fig. 10 is a fragmentary plan view, at a reduced scale,
20 of the interbody spacer member positioned between a pair of
21 adjacent vertebrae, with the spacer implanting tool still
22 engaged with the spacer and the vertebrae shown in phantom
23 lines.

1 Fig. 11 is a fragmentary, side elevational view of the
2 interbody spacer member positioned between the vertebrae
3 shown in cross section, with the spacer implanting tool
4 still engaged with the spacer.

5 Fig. 12 is a view similar to Fig. 10, at a somewhat
6 enlarged scale, and illustrates the beginning of retraction
7 of the spacer implanting tool from the spacer member with
8 the vertebrae shown in phantom.

9 Fig. 13 is a fragmentary top plan view illustrating an
10 interbody spacer member in place between a pair of vertebrae
11 that are shown in phantom and an end cap implanting tool
12 engaged with a winged end cap of the present invention just
13 prior to installation of the end cap on the spacer member.

14 Fig. 14 is a view similar to Fig. 13 and illustrates
15 the end cap just prior to complete engagement with the
16 interbody spacer member.

17 Fig. 15 is a further fragmentary view similar to Fig.
18 13 and illustrates the end cap fully secured to the
19 interbody spacer member.

20 Fig. 16 is an enlarged, fragmentary front elevational
21 view of the winged end cap fully implanted and engaging edge
22 regions of the adjacent pair of vertebrae.

1 Fig. 17 is a fragmentary enlarged longitudinal cross
2 sectional view of the interbody spacer member and end cap
3 engaged by an end cap removal tool.
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1 Detailed Description of the Invention

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3 As required, detailed embodiments of the present
4 invention are disclosed herein; however, it is to be
5 understood that the disclosed embodiments are merely
6 exemplary of the invention, which may be embodied in various
7 forms. Therefore, specific structural and functional
8 details disclosed herein are not to be interpreted as
9 limiting, but merely as a basis for the claims and as a
10 representative basis for teaching one skilled in the art to
11 variously employ the present invention in virtually any
12 appropriately detailed structure.

13 Referring to the drawings in more detail, the reference
14 numeral 1 generally designates a threaded center line cage
15 structure or assembly which embodies the present invention.
16 The assembly 1 generally includes an interbody spacer member
17 2 and an end cap member 3 that is operably secured to the
18 spacer member 2. The spacer member 2 and end cap 3
19 cooperate to maintain a beneficial spacing and mutual
20 orientation between a pair of adjacent vertebrae 6 and 7
21 (Fig. 11) and to resist side to side rotation of each
22 vertebrae 6 and 7 relative to the adjacent vertebrae 6 or 7.
23 The assembly 1 provides a stable relationship between the

vertebrae 6 and 7 with only a single spacer screw in type member 2 therebetween. By using a single spacer member 2 instead of a pair of laterally positioned spacers, an increased volume is provided between the vertebrae 6 and 7 to receive material which promotes bone fusion or osteosynthesis to thereby facilitate fusing together of the vertebrae 6 and 7.

The illustrated spacer member or cage 2 has a partial convex cylindrical shaped upper and lower (superior and inferior) surfaces 9 and 10 and concave cylindrical lateral surfaces 12. Front and rear (anterior and posterior) surfaces 14 and 15 are generally planar or flat. The upper and lower surfaces 9 and 10 are formed by a helical wound thread 17 which extend along the top and bottom of the spacer member 2. The upper and lower surfaces 9 and 10 are crests of the threads 17 which are constant in radius with spaces therebetween for each turn of the thread. Roots 19 associated with each full turn of the thread 17 have radii which diminish conically from front to rear within a conical region 21 and near the axial center of the spacer member 2 become constant throughout a rearwardly located partially cylindrical shaped region 23 that has the thread 17 extending outwardly between portions of the region 23

1 defined by the roots 19. The cylindrical region 23 begins
2 at the end of the conical region 21 with the shortest
3 radius, thereby giving the roots 19 a generally "funnel"
4 shaped profile, or side view, as illustrated in Fig. 2 and
5 by comparison of Figs. 3 and 4. The overall funnel shaped
6 surface is defined by the region covered by the thread roots
7 19 and has discontinuous turns spaced by the thread 17 and
8 the lateral surfaces 12.

9 Side areas 25 adjacent the thread roots 19 are
10 flattened or relieved from the concave cylindrical shape of
11 the lateral surfaces 12 to thereby increase the volume of
12 space between the vertebrae 6 and 7 to receive material
13 promoting fusion of the vertebrae. The flattened side areas
14 25 illustrated are approximately tangent to the lateral
15 surfaces 12 of the spacer member 2. Although not shown, it
16 is foreseen that the spacer member 2 could be provided with
17 additional openings, such as through and joining the lateral
18 surfaces 12, to provide additional volume between the
19 vertebrae 6 and 7 for receiving bone fusion promoting
20 material.

21 Referring to Figs. 1 and 13-16, the end cap 3 includes
22 a center section 30 and wing sections 32 extending laterally
23 of the center section 30 and curving in a posterior

1 direction therefrom. The front of the end cap 3 is
2 preferably sized, shaped and designed to follow the contour
3 of the front or anterior edge of the vertebrae 6 and 7. The
4 end cap 3 includes structure for securing it to the spacer
5 member 2. The illustrated end cap 3 includes a pair of
6 opposed resilient pawls 34 extending from a posterior
7 surface 36 (Fig. 13) of the end cap 3 at the center section
8 30. The pawls 34 are positioned to engage recesses 38
9 (Figs. 1 and 14) formed into the lateral surfaces 12 of the
10 spacer member 2 by deforming as the end cap is slid over the
11 anterior end of the spacer member (see Fig. 14) and then
12 resiliently returning to a gripping shape (as seen in Fig.
13 15) to hold the end cap 3 on the spacer number 2.
14 Alternatively, other structure or means for securing the end
15 cap 3 to the spacer member 2 may be employed in the assembly
16 1.

17 The illustrated wing sections 32 taper as they extend
18 from the center section 30 and curve backward or in a
19 posterior direction relative to the spine, such that the
20 posterior surface 36 is concave and an opposite anterior
21 surface 40 (Fig. 13) of the end cap 3 is convex. The
22 curvature of the wing sections 32 is intended to conform to
23 the curvature of an outer region 42 (Figs. 13 and 14) of the

vertebrae 6 and 7. The tapered shape of wing sections 32 is intended to generally conform to outer regions of the vertebrae 6 and 7 when they are in the desired degree of lordosis or angular relation, so that an upper and lower surface 43 engages the strongest and hardest portion of the anterior end plate of each vertebrae 6 and 7. The outer regions 42 of the vertebrae 6 and 7 surround inner regions 44 thereof. The wing sections 32 preferably include apertures 46 formed therethrough to provide for the implanting of spinal fusion promoting material between the vertebrae 6 and 7 after the assembly 1 is implanted.

The cage assembly 1 is preferably formed of a strong, light weight material which either does not react at all with the tissues and chemicals within its implanted environment or which does react therewith only in a beneficial manner. The materials may include various metallic alloys, such as stainless steels, titanium alloys, or tantalum alloys or synthetic materials or composites, such as resins, polymers, or carbon fiber reinforced polymers. It is also foreseen that the assembly 1 can be formed of a material which will be replaced by the body, over time, by boney tissue. Biological implants of this type may be constructed of bone or bone based material or

1 certain bio-active resins. The spacer member 2 and end cap
2 3 may be manufactured using any of a number of known
3 processes, such as casting or molding, machining, sintering,
4 or combinations of such processes.

5 Figs. 5-8 illustrate stages in the preparation of
6 vertically adjacent vertebrae 6 and 7 for implanting the
7 center line cage assembly 1 therebetween. Fig. 5 is a
8 simplified view of the two adjacent vertebrae 6 and 7
9 separated by an intervertebral disc 50, with ligaments and
10 other structures omitted for simplicity. When the disc 50
11 is malformed, injured, diseased, mispositioned by age or
12 injury, or the like and does not respond to less radical
13 treatments, it is sometimes necessary and/or beneficial to
14 remove the disc 50, by a laminectomy procedure, and to
15 replace the disc 50 by spacer structure which maintains the
16 mutual spacing and angular orientation of the vertebrae 6
17 and 7 in a normal configuration or even produces an improved
18 alignment so as to help correct spinal curvature problems.
19 Often, such spacer structure is used in conjunction with
20 techniques to fuse the vertebrae 6 and 7 into a permanently
21 fixed relationship.

22 Fig. 6 illustrates the vertebrae 6 and 7 subsequent to
23 the laminectomy and with a pair of vertebrae spreading tools

1 52 of a scissors type inserted between the vertebrae 6 and
2 7. Fig. 7 shows the vertebrae 6 and 7 spread apart a
3 desired distance, using the tools 52, and upper and lower
4 radiused channels 54 which have been cut partially into
5 respective mutually facing surfaces 55 and 56 of the
6 vertebrae 6 and 7 to receive the partly screw in spacer
7 member 2. Fig. 8 shows the vertebra 7 with the partial
8 cylindrical channels 54, and also illustrates the
9 positioning of the tools 52 during the implantation
10 procedure.

11 Figs. 9-12 illustrate stages in the implantation of the
12 spacer member 2 between the vertebrae 6 and 7, using a
13 spacer implanting tool 60. The tool 60 has an inner rod 62
14 terminating in a threaded distal (to the surgeon) end 64 and
15 a knob 66 at an opposite proximal end. The rod 62 is
16 positioned coaxially within an outer tube 68 by a plurality
17 of axially spaced bushings 70 (Fig. 10). The tube 68 has a
18 pair of diametrically spaced paddles 72 at a distal end and
19 a pair of transversely extending handles 74 at an opposite
20 proximal end. The paddles 72 have external threads 76 which
21 have the same radius and are compatible with the threads 17
22 of the spacer member 2. Additionally, the paddles 72 have
23 inner convex surfaces 78 which are cylindrical with the same

1 cylindrical radius as the concave lateral surfaces 12 of the
2 spacer member 2.

3 The spacer implanting tool 60 is used to implant the
4 spacer member 2 between the vertebrae 6 and 7 within the
5 center line channels 54 which have been previously cut into
6 the vertebrae 6 and 7, while at a desired spacing. The tool
7 60 is engaged with the spacer member 2 with the paddles 72
8 on opposite sides, such that the inner cylindrical surfaces
9 78 snugly engage the lateral cylindrical surfaces 12 of the
10 spacer member 2. The paddle threads 76 are formed in such a
11 manner that when the paddles 72 are properly positioned
12 axially with respect to the spacer member 2, the paddle
13 threads 76 form a continuous helical thread with the threads
14 17 on the upper and lower surfaces 9 and 10 of the spacer
15 member 2. With the paddles 72 thus positioned relative to
16 the spacer member 2, the threaded end 64 of the rod 62 is
17 threaded into a threaded bore or socket 80 (Fig. 1) formed
18 into the front surface 14 of the spacer member 2 and
19 tightened using the knob 66.

20 When the tool 60 has been secured to the spacer member
21 2, the spacer member 2 is threaded or screwed into the
22 spaced vertebral channels 54. As the spacer member 2 and
23 paddles 72 are threaded between the vertebrae 6 and 7, the

1 threads 17 and 76 tap a thread into the channels 54.
2 Threading continues until the spacer member 2 is properly
3 positioned relative to the vertebrae 6 and 7 to engage the
4 inner or central regions 44 thereof. Rotation of the spacer
5 member 2 is stopped when in an upright orientations (Figs.
6 10 and 11) so that the upper and lower surfaces 9 and 10
7 thereof respectively engage the upper and lower vertebrae 6
8 and 7.

9 To remove the spacer implanting tool 60 from the spacer
10 member 2, once it is implanted in a desired position and
11 orientation, the outer tube 68 is translated in a proximal
12 direction relative to the inner rod 62, leaving only a
13 portion of the paddles 72 engaging the lateral surfaces 12
14 of the spacer member 2 (Fig. 12). The tube 68 is then held,
15 using the handles 74, while the rod 62 is rotated, using the
16 knob 66, to unthread the end 64 thereof from the bore 80 in
17 the front end 14 of the spacer member 2. Afterwards, the
18 paddles 72 are fully withdrawn from the lateral surfaces or
19 sides 12 of the spacer member 2.

20 Figs. 13-15 illustrate stages in the connection of the
21 end cap 3 to the previously implanted spacer member 2. Fig.
22 13 illustrates an exemplary end cap implanting tool 85 which
23 may be used for this purpose. The tool 85 has a shaft 86

1 with a pair of handles 87 at a proximal end and a threaded
2 distal end 88 joined to the shaft 86 at a shoulder 89. The
3 threaded end is sized to fit into the threaded bore 80 of
4 the spacer member 2. The threaded end 88 is inserted
5 through a threaded bore 92 formed through the center section
6 30 of the end cap 3 and threadedly engaged with the threaded
7 bore 80 in the spacer member 2. The shaft 86 is rotated,
8 using the handles 87, to thread the end 88 further into the
9 bore 80, thereby urging the shoulder 89 against the anterior
10 surface 40 of the center section 30. By this means, the
11 pawls 34 are urged past the front surface 14 of the spacer
12 member 2 and into the pawl receiving recesses or grooves 38
13 formed into the lateral surfaces 12 of the spacer member 2.
14 When that occurs, the center section 30 and wing sections 32
15 of the end cap 3 are generally aligned with the outer
16 regions 42 of the vertebrae 6 and 7, for engagement thereby.
17 The center section 30 preferably has upper and lower edge
18 surfaces 94 which are cylindrical in shape and of the same
19 diameter as the center line channels 54 for close engagement
20 and support of the center section with the vertebrae 6 and 7
21 at the outer regions 42 (see Fig. 16) at the channels 54.
22 Although the end cap 3 will typically be permanently
23 left attached to the spacer member 2, under some

1 circumstances, it may be necessary to detach the end cap 3
2 therefrom. Fig. 17 illustrates an end cap removal tool 96
3 which may be used for such a purpose. The tool 96 has a
4 shaft 97 terminating in a threaded distal end 98 with an
5 abutment surface 99 at an ultimate end. The threaded end 98
6 is sized and threaded to fit into the threaded bore 92 in
7 the center section 30 of the end cap 3 and is too large to
8 fit into the threaded bore 80 of the spacer member 2. When
9 it is necessary to detach an end cap 3 from an implanted
10 spacer member 2, the threaded end 98 is threaded into the
11 bore 92 until the abutment surface 99 engages the front
12 surface 14 of the spacer member 2. Rotation of the shaft 97
13 continues, using a handle (not shown) thereon, to urge the
14 end cap 3 anteriorly away from the spacer member 2, thereby
15 deforming and retracting the pawls 34 from the recesses 38
16 in the side surfaces 12 of the spacer member 2. Rotation
17 may be continued until the pawls 34 clear past the front
18 surface 14 of the spacer member 2 and the end cap 3 is then
19 pulled from the spacer member 2.

20 The cage assembly 1 of the present invention enables
21 the use of a single spacer member or cage 2 positioned along
22 a "center line" of the vertebrae 6 and 7, that is, within a
23 median plane 102 (Fig. 13) of the body incorporating the

1 vertebrae 6 and 7. The spacer member 2 engages inner
2 regions 44 of the mutually facing vertebral surfaces 55 and
3 56 of the vertebrae 6 and 7. The end cap 3 engages outer
4 regions 42 of the vertebrae 6 and 7 and, thereby, cooperates
5 with the spacer member 2 to provide lateral stability to the
6 vertebrae 6 and 7 with the spacer member 2 implanted
7 therebetween and located on the center line 102.
8 Additionally, the funnel shaped profile of the roots 19 of
9 the thread 17 of the spacer member 2 promotes a favorable
10 angular or lordotic relationship between the vertebrae 6 and
11 7 (Fig. 11).

12 It is to be understood that while certain forms of the
13 present invention have been illustrated and described
14 herein, it is not to be limited to the specific forms or
15 arrangement of parts described and shown.

16